Landscape-level Behavior, Distribution and Abundance of Glassy-winged Sharpshooter

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Current Grant - GWSS

R. Mizell and P. Andersen

Title: Improved Detection, Monitoring & Management

Objectives: determine most effective trapping system

- **Synthesize report on previous sampling and trapping efforts**
- **Trap configuration and number for detection-monitoring**
- **Host plant effects in combination with traps**

Project status:

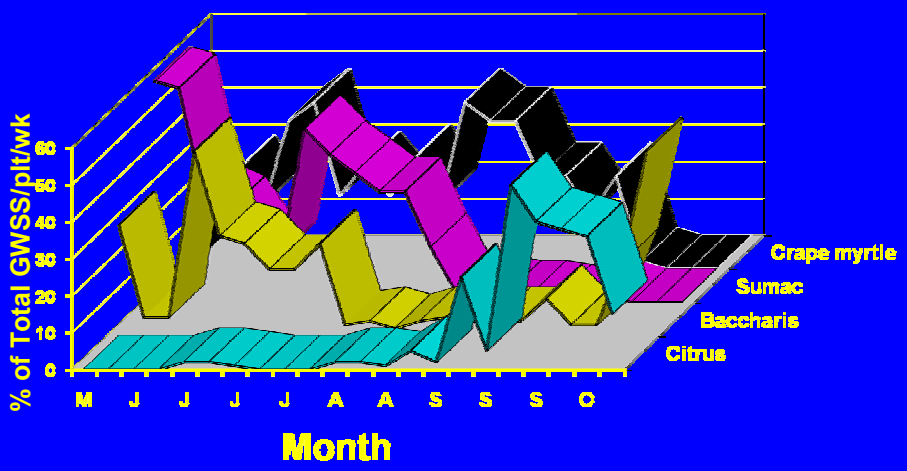
- **Unpublished research, manuscripts in prep.**
- **Research- 2008 season.**

Available GWSS monitoring and detection methods are POOR!

Landscape-level Behavior, Distribution and Abundance of GWSS

Pertinent to trapping

Seasonal Use of Host Plants By GWSS In North Florida



Mizell & French 1987

Xylem Fluid

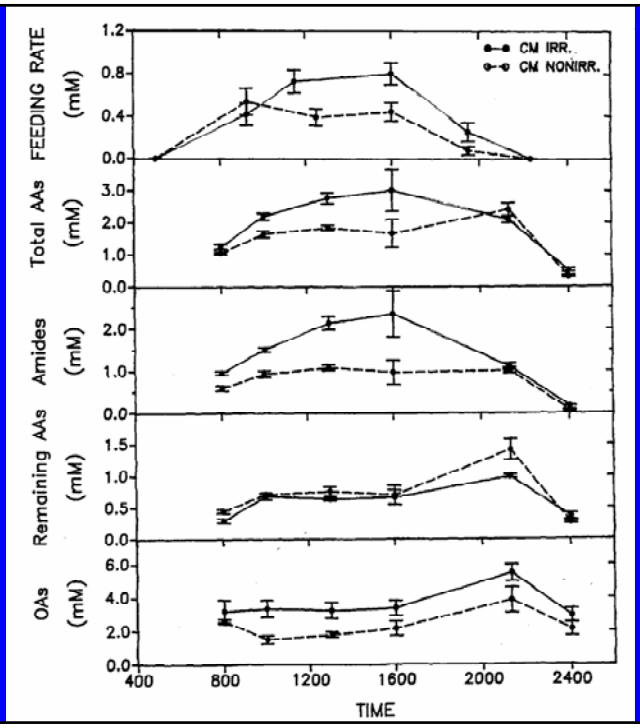
- 50 % Inorganic:
- 50 % Organic:

45% AA
45% OA
< 5% Sugar

5% Unknown:

Steroids,
Proteins
Enzymes?

Vector Feeding & Diurnal Plant Nutrient Cycling



Leafhoppers As Xylem Feeders

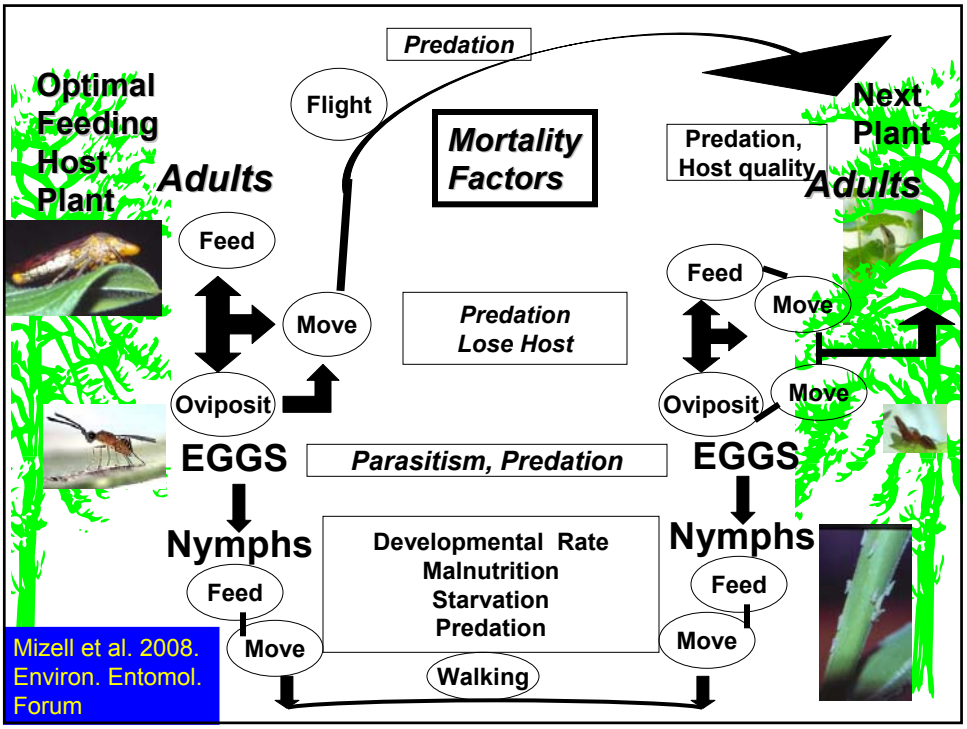
Factors:

- **Host plant nutrient quality – changes w/time**
- **Dilute, unbalanced profiles – AA, OA**
- **Negative xylem pressure – extraction cost?**
- **Nymphs (1-3) differ from adults & nymphs (4-5) (balance w/ high essential AA needed)***

Leafhoppers As Xylem Feeders

Adaptations/benefits:

- Change plants to handle risk factors
- High consumption rate >10x wgt
- High metabolic efficiency - >99-100%
- Ammonotelism - max energy- min waste
- RAM (Amides/TOC)-feeding stimulant
- Few xylem defensive chemicals



Methodology
Landscape Level Movement

- Trapping studies
- Mark-recapture
- ArcView 9.2: geospatial analyses
- SADIE – aggregation and distribution
- SAS Repeated Measures – population dynamics

Previous research:
Park et al. California, 1 sq mile grid

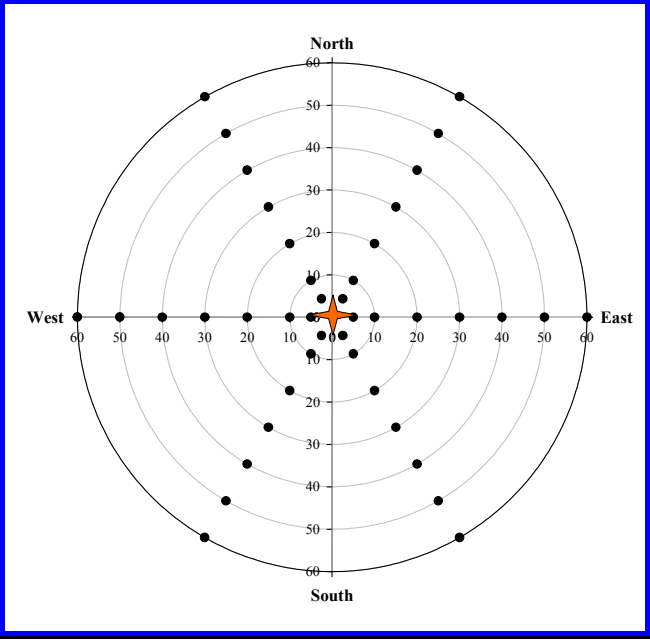
Effects of Host Species & Phenology Using Mark-Recapture

Effects of host plant type on diffusion in a host patch (time & distance)

- Blackmer et al. 2004, 2006

- Patch leaving behavior
  - Host plant type – peach, crape myrtle
  - Host plant phenology – peach
  - Mizell & French 1987, Andersen et al. 1992, etc.

Mark-Recapture Experimental Design



Peach &

Crape myrtle

Marker :

Colored Hair Spray

Northfield et al. 2008

Effect of Host Species & Phenology - M/R

Peach, *Prunus persica* **Crape Myrtle, *L. indica***

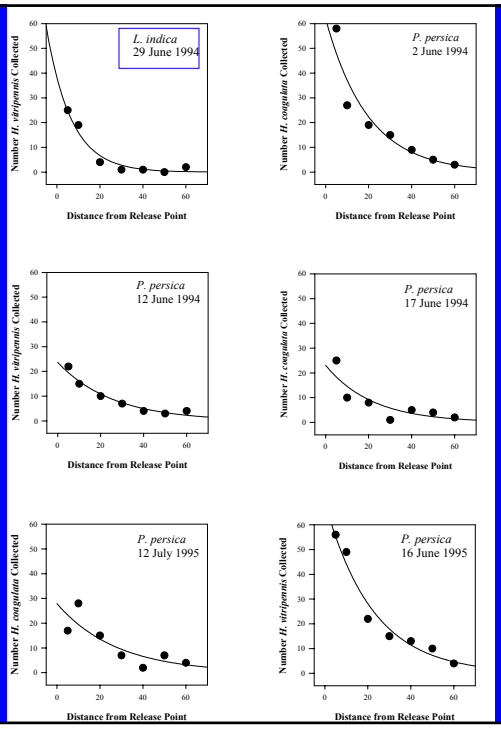
Date	Adults Released	Date	Adults Released
2-Jun-94	1423	29-Jun-94	1090
12-Jun-94	1076	9-Jul-07	1026
17-Jun-94	889		
16-Jun-95	2224		
12-Jul-95	754		

Diffusion Distance & Leaving Time

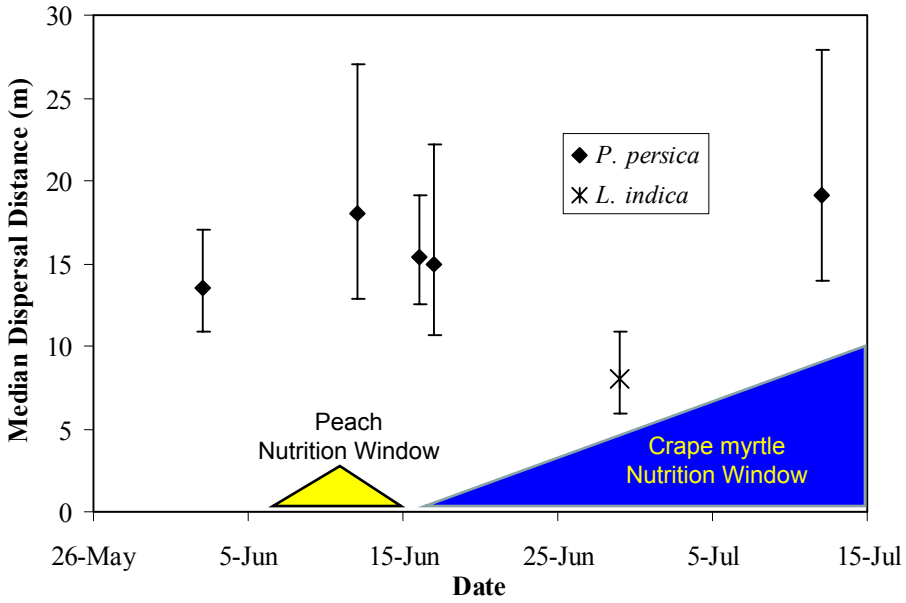
Dispersion model: $N(r)=a\exp^{-br}$
Turchin & Thoeny .1993. Ecol. Appl. 3:187-198.

- Max-likelihood estimation using χ^2 distribution
- Median diffusion distance – 50% capture radius
- Patch leaving – time 50% of population captured
  – half-life in the patch
- Treatment diff. - conf. interval overlap

Distance Moved from Center Release Point on Preferred & Non-preferred Hosts



Median Dispersal Distance of Released GWSS in Preferred and Non-preferred Host Plots



Movement Time from Center Release Point on Preferred & Non-preferred Hosts

Dispersion model: $N(r)=a\exp^{br}$
Turchin and Thoeny 1993.
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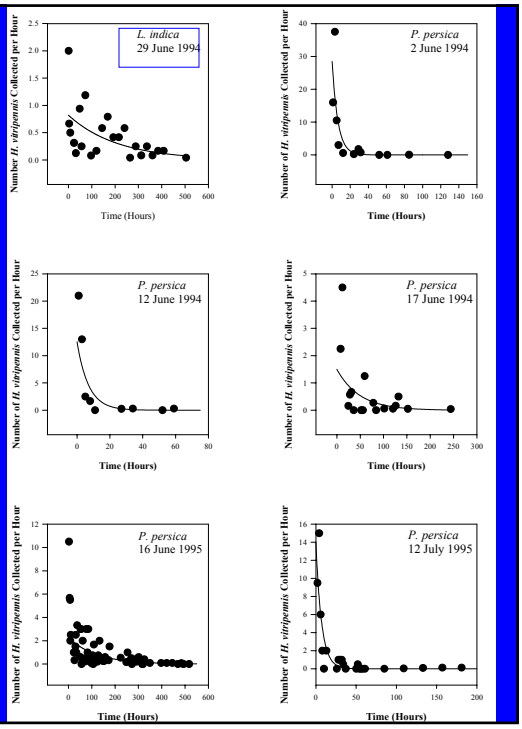
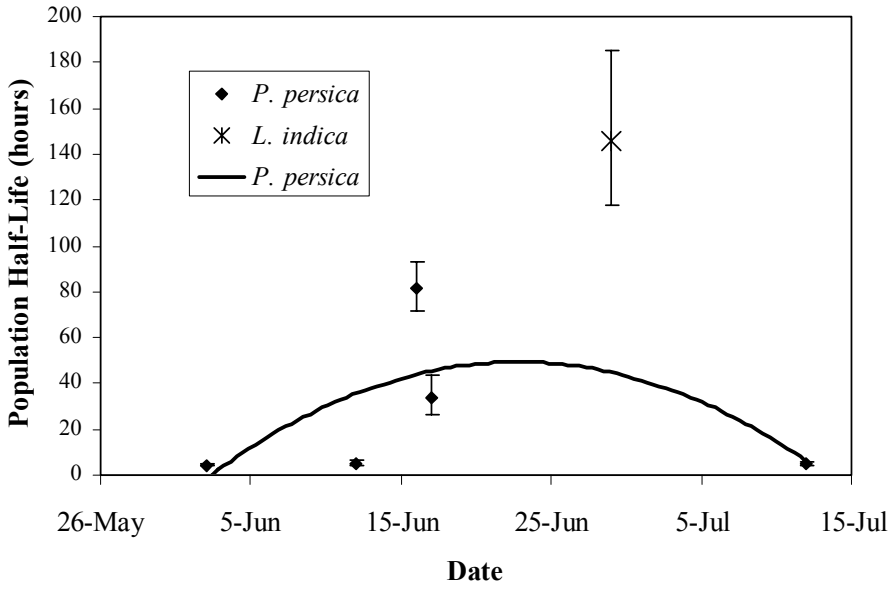


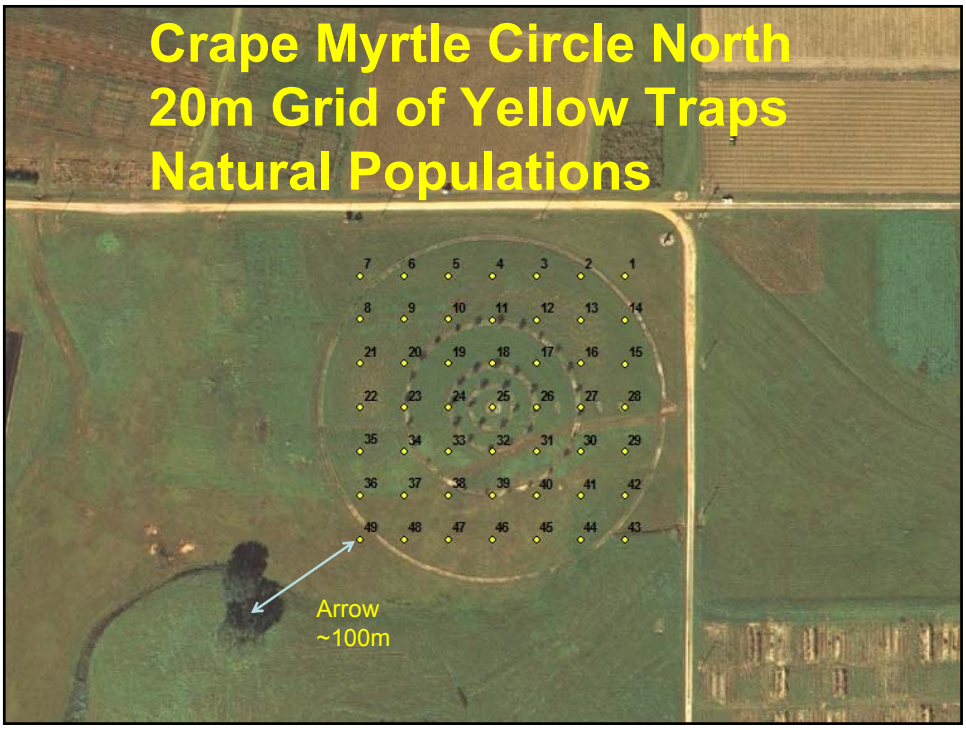
Half-life (Time Spent) of GWSS Populations Released in Preferred and Non-Preferred Host Patches



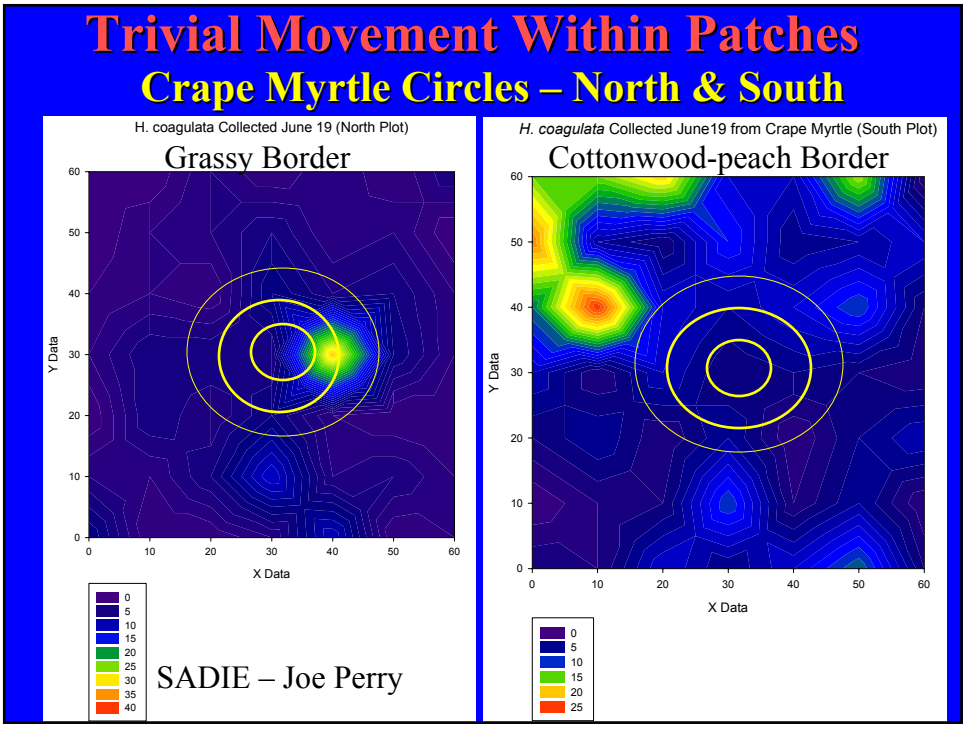
Conclusions

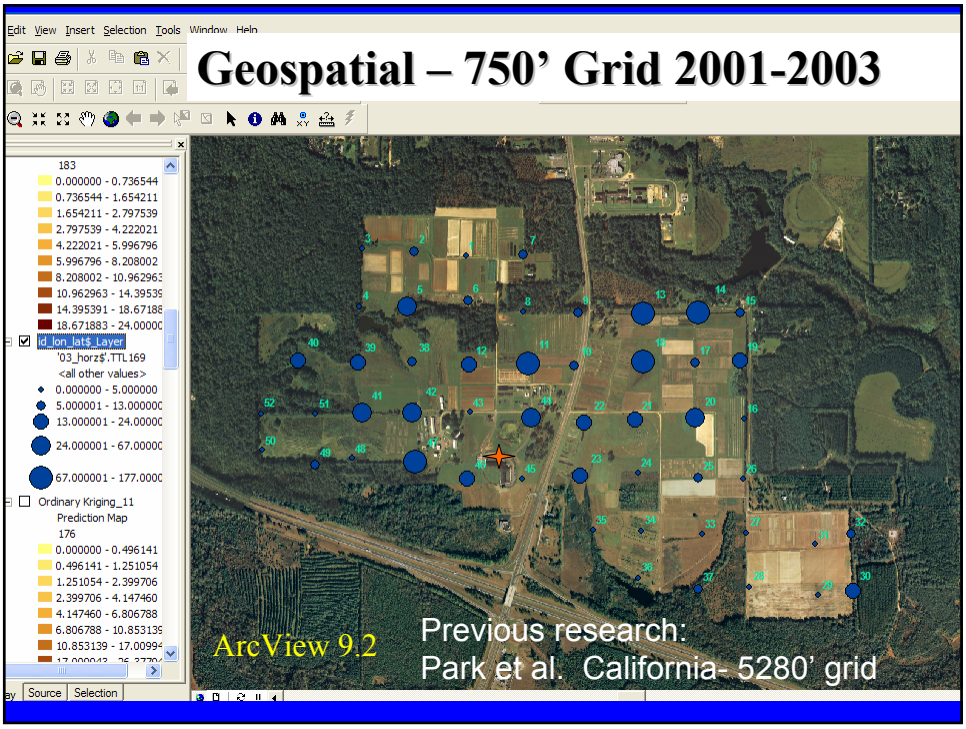
- *H. vitripennis* diffusion correlated w/ host species
- *H. vitripennis* patch residence time correlated w/
  - Host patch species
  - Host patch phenology (Peach)

Relative value and change in nutrient content

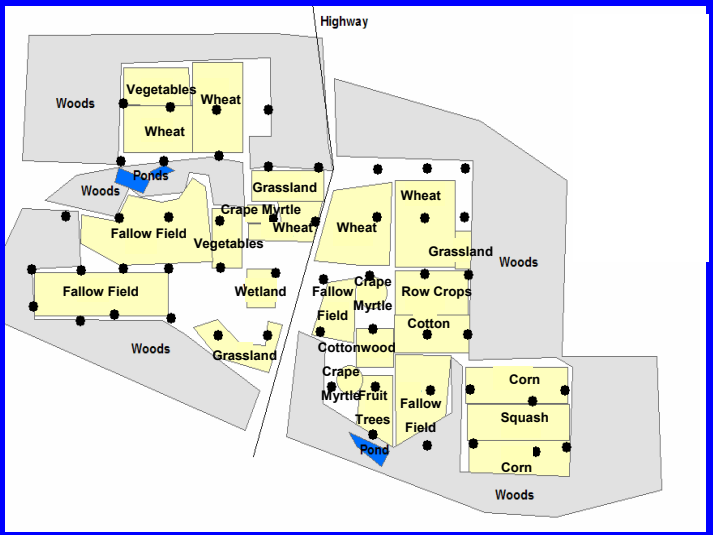


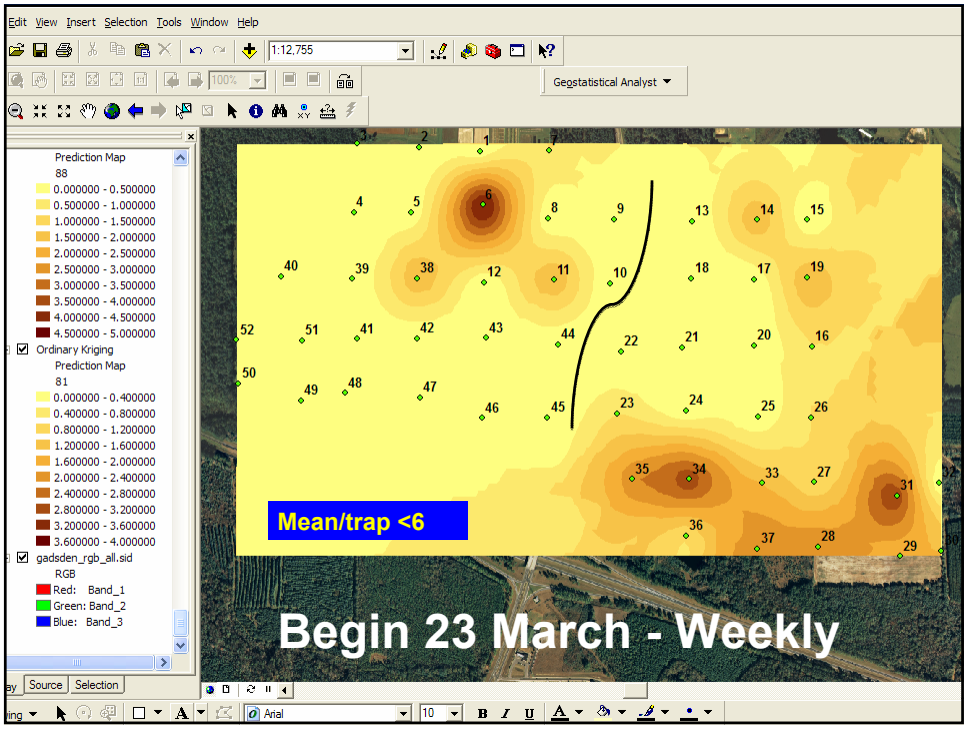

Crape Myrtle
Circle South
20 m grid
7 6 5 4 3 2 1
8 9 10 11 12 13 14
21 20 19 18 17 16 15
22 23 24 25 26 27 28
35 34 33 32 31 30 29
36 37 38 39 40 41 42
49 48 47 46 45 44 43

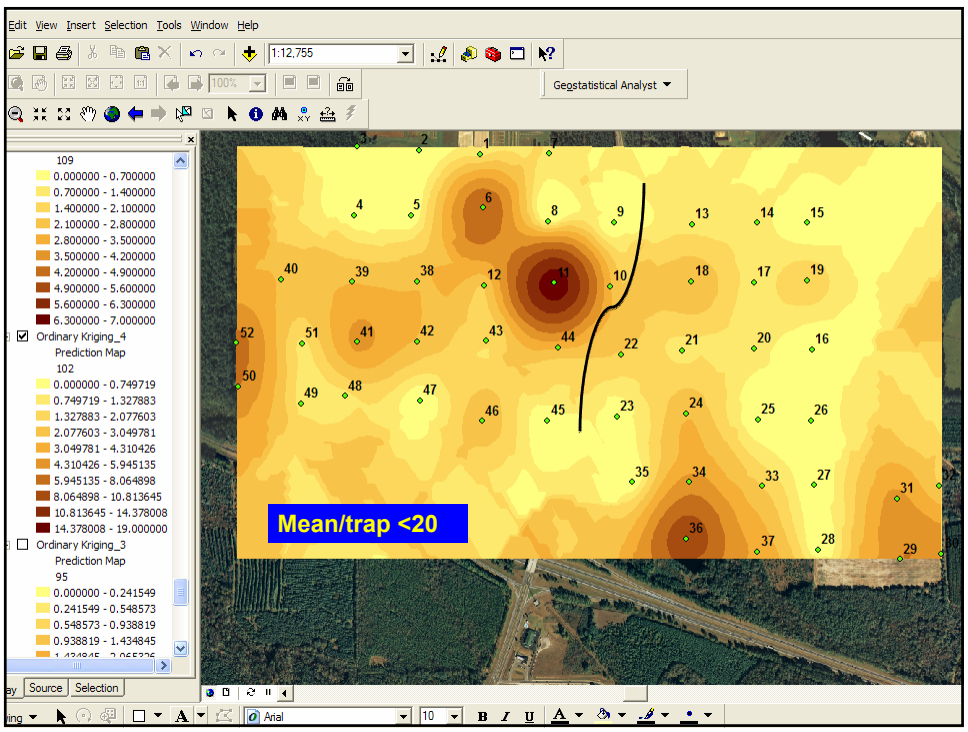

Trivial Movement Within Patches
Crape Myrtle Circles – North & South
H. coagulata Collected June 19 (North Plot)
Grassy Border
Y Data
X Data
0 10 20 30 40 50 60
0 5 10 15 20 25 30 35 40
SADIE – Joe Perry
H. coagulata Collected June19 from Crape Myrtle (South Plot)
Cottonwood-peach Border
Y Data
X Data
0 10 20 30 40 50 60
0 5 10 15 20 25

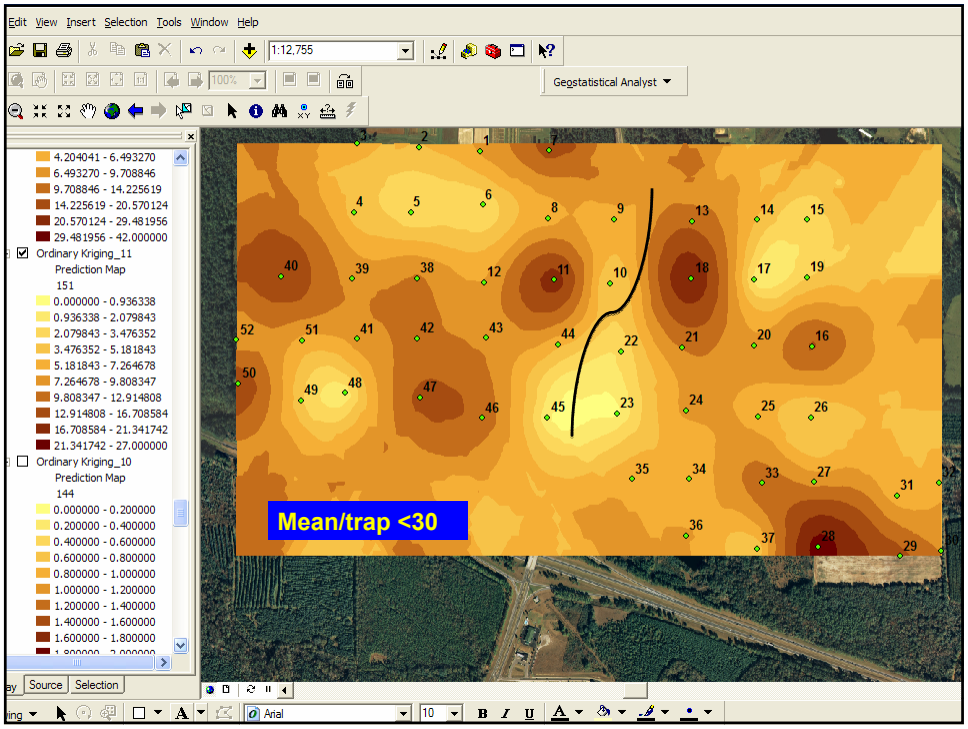


Landscape Composition

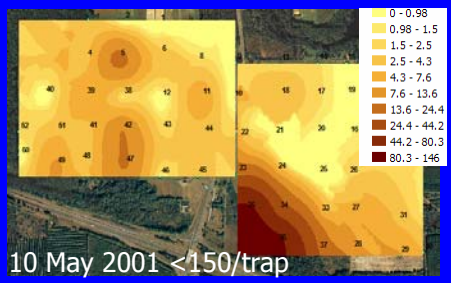



Edit View Insert Selection Tools Window Help
1:12,755
Geostatistical Analyst
Prediction Map
88
0.000000 - 0.500000
0.500000 - 1.000000
1.000000 - 1.500000
1.500000 - 2.000000
2.000000 - 2.500000
2.500000 - 3.000000
3.000000 - 3.500000
3.500000 - 4.000000
4.000000 - 4.500000
4.500000 - 5.000000
Ordinary Kriging
Prediction Map
81
0.000000 - 0.400000
0.400000 - 0.800000
0.800000 - 1.200000
1.200000 - 1.600000
1.600000 - 2.000000
2.000000 - 2.400000
2.400000 - 2.800000
2.800000 - 3.200000
3.200000 - 3.600000
3.600000 - 4.000000
gadsden_rgb_all.sid
RGB
Red: Band_1
Green: Band_2
Blue: Band_3
Source
Selection
Arial
10
Mean/trap <6
Begin 23 March - Weekly

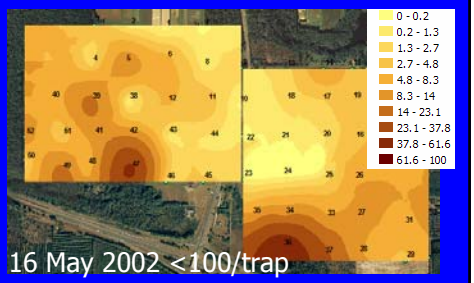

Edit View Insert Selection Tools Window Help
1:12,755
Geostatistical Analyst
109
0.000000 - 0.700000
0.700000 - 1.400000
1.400000 - 2.100000
2.100000 - 2.800000
2.800000 - 3.500000
3.500000 - 4.200000
4.200000 - 4.900000
4.900000 - 5.600000
5.600000 - 6.300000
6.300000 - 7.000000
Ordinary Kriging_4
Prediction Map
102
0.000000 - 0.749719
0.749719 - 1.327883
1.327883 - 2.077603
2.077603 - 3.049781
3.049781 - 4.310426
4.310426 - 5.945135
5.945135 - 8.064898
8.064898 - 10.813645
10.813645 - 14.378008
14.378008 - 19.000000
Ordinary Kriging_3
Prediction Map
95
0.000000 - 0.241549
0.241549 - 0.548573
0.548573 - 0.938819
0.938819 - 1.434845
Source
Selection
Arial
10
Mean/trap <20



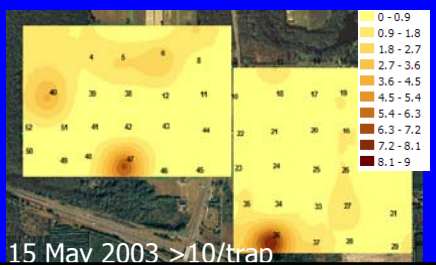
Mid May Population Distributions



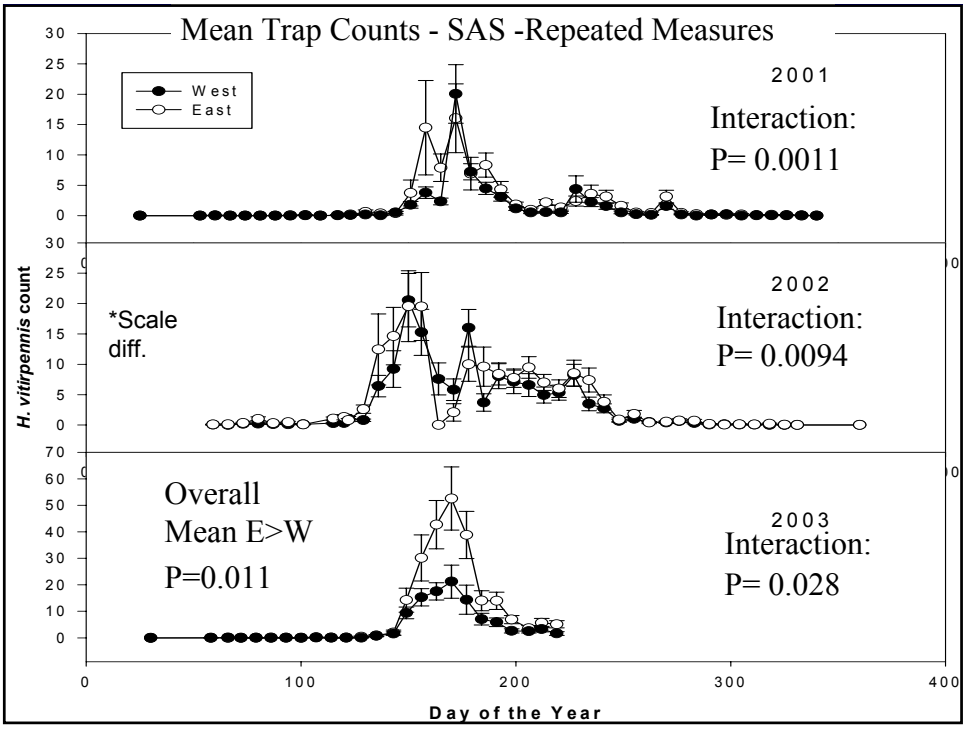
10 May 2001 <150/trap



16 May 2002 <100/trap



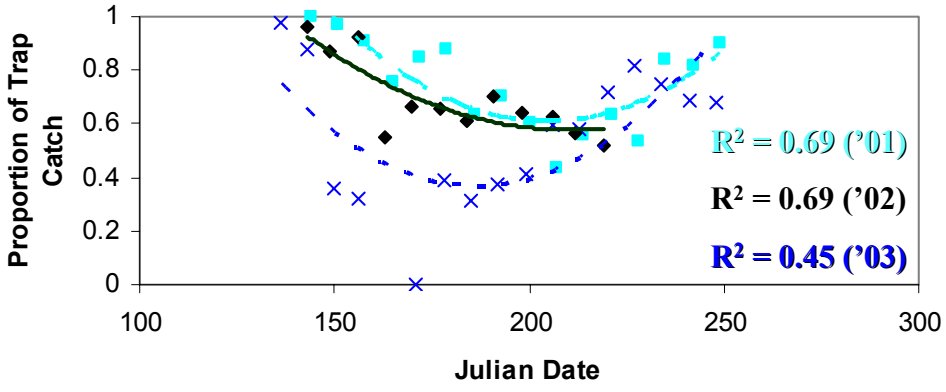
15 May 2003 >10/trap



Eastern Population

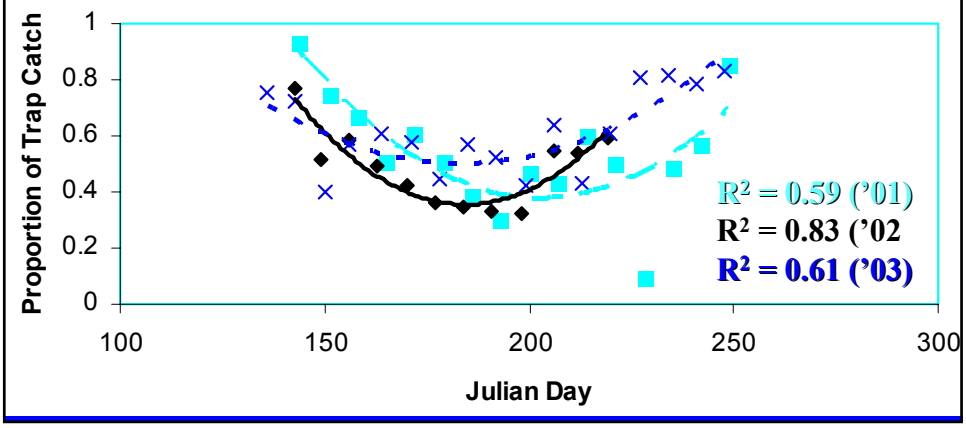
(Kaloostian and Turner 1964)

Proportion of Trap Catch on Forrest Edge in 2001-03 (Green, Blue, Black) Eastern Population

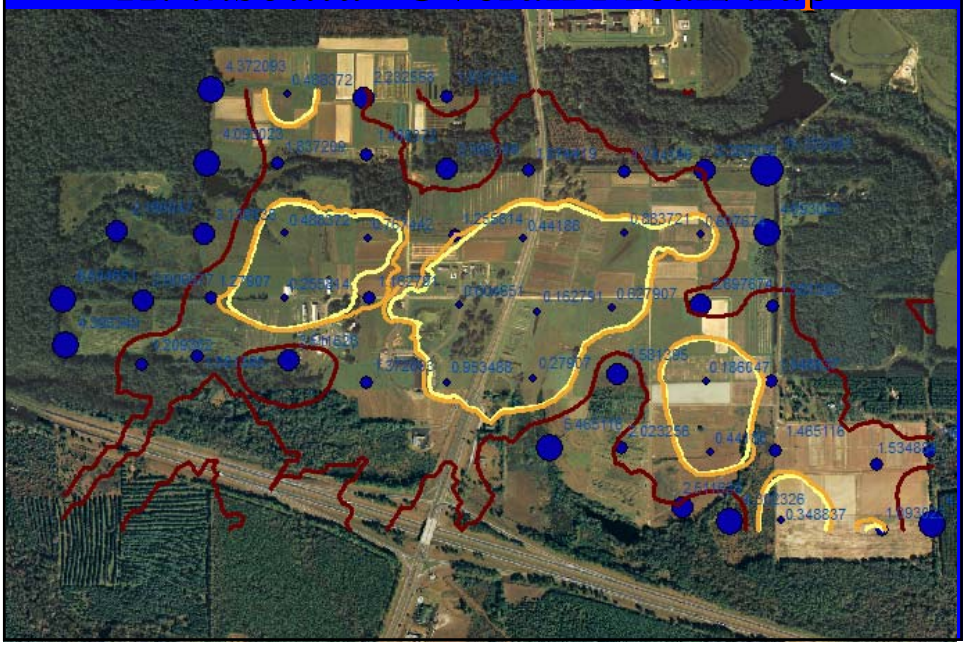


Western Population

Proportion of Trap Catch On Forest Edge 2001-03 (Green, Blue, Black) in Western Population



H. insolita- Overall Mean/trap



Spatial Analysis of Distance Indices (SADIE)

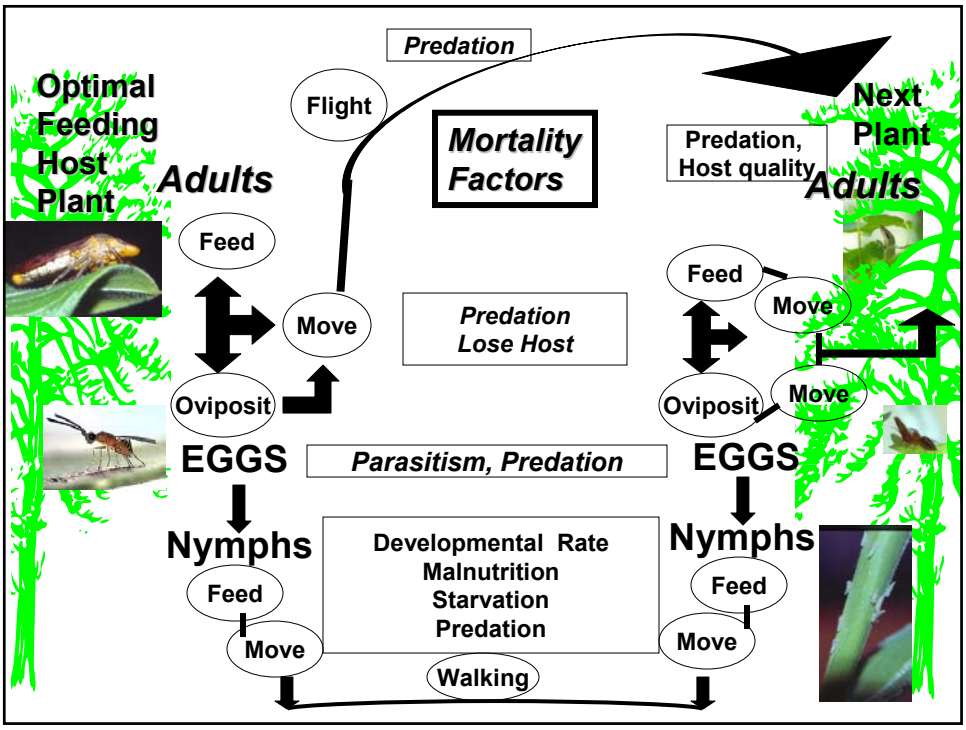
- **Spatial Association between two dates**
  - Compares changes in distribution over time (Spatiotemporal stability)
    - Distribution changes within a season
    - Distribution differences between years (rainfall)

Spatiotemporal Stability Tests

		East		West	
Date 1	Date 2	X	p	X	p
10-May-01	7-Jun-01	0.6371	0.0016***	Insufficient Data	
16-May-02	30-May-02	-0.6093	0.998†††	-0.357	0.958
15-May-03	29-May-03	0.5881	0.0016***	0.482	0.0076*
7-Jun-01	21-Jun-01	0.8174	<.0001***	0.524	0.0038**
30-May-02	27-Jun-02	-0.306	0.915	0.184	0.221
29-May-03	20-Jun-03	0.4681	0.0172*	0.273	0.0832
7-Jun-01	30-May-02	-0.5025	0.998†††	-0.283	0.898
30-May-02	29-May-03	-0.3972	0.947	-0.0348	0.563
7-Jun-01	29-May-03	0.3117	0.098	0.230	0.126

Spatiotemporal Dynamics: Conclusions

- Migration pattern to and from forest edges in N. Florida
- 750' grid – too large
- Spatiotemporal stability correlated w/ environmental conditions
  - Nutrient availability – hosts change
  - Higher patch leaving w/lower rainfall



What Are the Potential GWSS Host Plant Types?

Type	Adult	Egg	Nymph	Parasite
Non-Host	N	Y/N	Y/N	Y/N
Primary	Y	Y	Y	Y
Adult only	Y	Y/N	Y/N	Y/N
Nymph only	N	Y/N	Y	Y/N
Enemy-free	Y	Y	Y	N
Suicide	Y	Y	N	Y/N

How Might We Manipulate GWSS/XF Host Types?

- Primary Host — remove
- Enemy-free Host — remove
- Non-Host — add -barrier
- Adult Host — trap crop
- Suicide Host — trap crop

Host Type Matrix
Vectors?

Adults	Poor	Fair	Great
	Nonhosts		
Propagative		Nonpropagative	
Systemic		Nonsystemic	
Pathological		Nonpathological	
Oviposition	Poor	Fair	Great
Nymphs	Poor	Fair	Great

Xylella fastidiosa

Purcell & Saunders 1999
Plt Dis. 83:825-830

Trapping Efficiency??

- **Trap efficacy – poor!**
- **GWSS distribution & abundance**
  - **host plant quality**
  - **host plant arrangement - fragmentation**
  - **landscape structure – movement**
    - **edges, corridors, barriers**
- **Exploit factors**
  - improve monitoring, detection
  - deploy multiple tactics within habitat manipulation strategy

Questions

Spatial Analysis of Distance Indices (SADIE)

- **Spatial Association between two dates**
  - Compares changes in distribution over time (Spatiotemporal stability)
    - Distribution changes within a season
    - Distribution differences between years

Spatiotemporal Stability Analysis

- **Measures local spatial associations indices (X_i) between the same data points for different dates**
- **Calculates Association Index**
  $X = \Sigma_i X_i / n$
- **Compares to random association indices**
  X_{rand}
- **Calculates p**
  - Probability that a two randomly selected populations would be more associated than the focal data
  - Two-tailed test

Spatiotemporal Stabilty Analysis

- **Within season spatiotemporal stability between:**
  - Mid-May and 1st population peak (early June)
  - First population peak and late June
- **Between Years**
  - First population peak of season

Spatiotemporal stability in drought and normal years

- **Compared within season spatiotemporal stability**
- **Compared between year spatiotemporal stability**
- **Rainfall:**
  - 2001
    - 45.6 cm
  - 2002
    - 11.9 cm
  - 2003
    - 40.7 cm

M/R - Diffusion Distance Analysis (1)

- Diffusion distance after 5 days
- Fit data to negative exponential model

$N(r) = a \exp^{-br}$

$N(r)$ = number captured at radius r
a = scaling parameter
b = spatial scale parameter

M/R- Diffusion Distance Analysis (2)

- Median diffusion distance equation:

$r^{0.5} = \ln(2)/b$

$r^{0.5}$ = radius where 50% insects collected

b = spatial scale parameter

M/R - Patch Leaving Analysis (3)

- **Counted number of insects captured each time step**
- **Fit data to negative exponential model**

  $N(t) = a \exp^{-bt}$

  N(t) **= number collected at time t**

  a **= scaling parameter**

  b **= temporal scale parameter**
- **Estimate time at which 50% of population captured**

  $t^{0.5} = \ln(2)/b$

M/R - Patch Leaving Analysis (4)

- Maximum likelihood estimation
  - Used to fit models to data
  - Calculate 95% confidence intervals
    - Based on χ^2 distribution
- Treatments considered significantly different if 95% CI do not overlap